2. EXHIBIT 2 GENERAL DESCRIPTION

2.1 Overview

The PCS-Over-Cable system provides an economical means to distribute wireless Personal Communications Systems (PCS) services over available CATV infrastructures. The PCS-Over-Cable System was developed specifically to support the ANSI-J-STD-019 Code Division Multiple Access (CDMA) protocol. The CATV fiber/coax network is used to distribute the PCS signals between the cable headend facility and attached remote locations throughout the service area. A Cable Microcell Integrator (CMI) at each remote location converts the cable-based signal to PCS frequencies and radiates/receives through a set of three antennas at each CMI location. One Headend Interface Converter (HIC) provides the CATV interface at the headend facility for up to three CDMA sectors.

This system is intended for vendors of PCS equipment. It is not intended for sale to the general public. CATV companies affiliated with PCS licenseholders and providers (i.e. PCS PrimeCo, Sprint) would install and operate the CMI and HIC hardware.

This particular PCS-over-Cable variant, known as V1.9, is similar to the V1.75 hardware which was granted type acceptance in October 1996. (reference FCC ID L5H94117V175).

The V1.9 hardware comprises three basic sets of hardware configurations, each of which covers two adjacent PCS frequency blocks within the 1930-1990 MHz Broadband PCS allocation. Sanders intends to sell large quantities (thousands) of production-type units.

A more detailed description of the hardware is provided below and in Exhibit 7.

2.2 System Description

Figure 2-1 shows the basic PCS-Over-Cable System elements. The headend facility contains PCS-Over-Cable System equipment, telephony equipment and the existing video services equipment traditionally found in a headend. This document specifically describes the PCS-Over-Cable System equipment. Since the interfacing telephony equipment will depend upon the specific equipment and service provider, telephony equipment is mentioned only to describe pertinent interfaces.

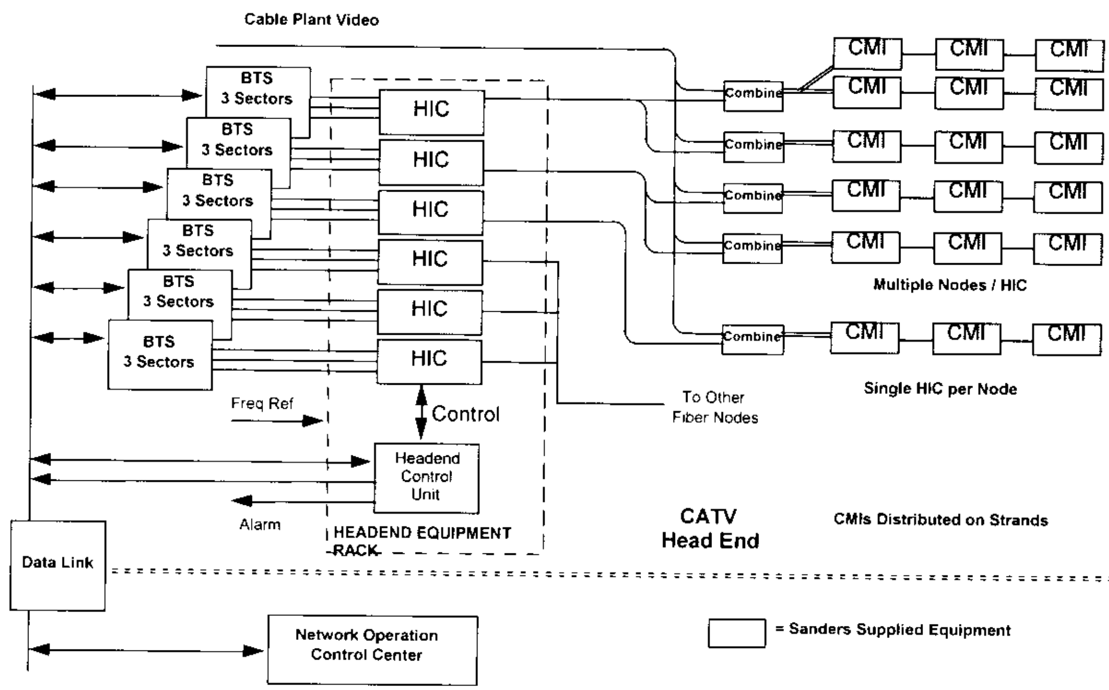
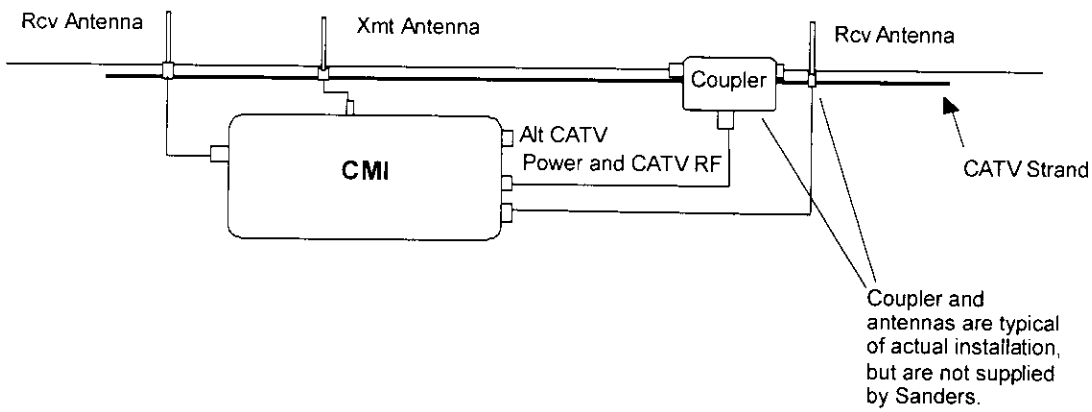


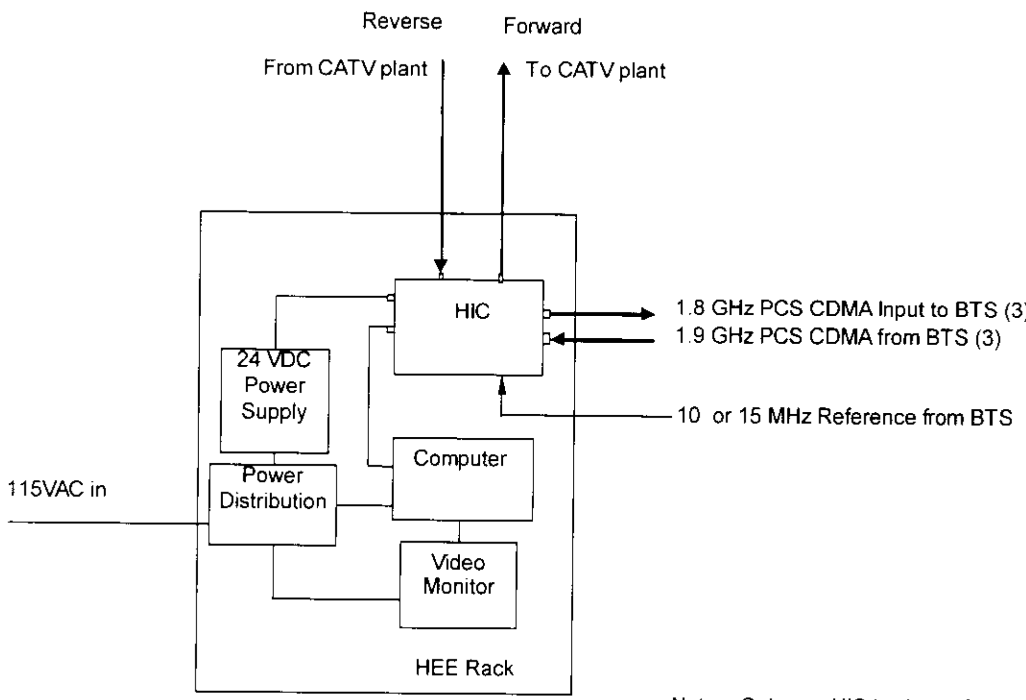
Figure 2-1. Basic Elements of the Cable-Based PCS System

The headend components of the PCS-Over-Cable System are the HIC and the Headend Control Unit (HECU). These are installed in the Headend Equipment Rack (HEE), which is supplied by Sanders. The pertinent telephony component is the Base Transceiver Station (BTS) located at the headend. The Network Operation Control Center (NOCC) may span multiple headend facilities and/or traditional tower-based PCS sites.

Up to three CDMA sectors of the BTS telephony equipment will interface to the cable plant through a single HIC unit. A CDMA sector/HIC can interface to single or multiple cable plant fiber nodes, depending on the differences between fiber node coverage and the desired coverage of a single CDMA sector. Any number of CDMA sectors/HICs may be combined for operation on a single fiber node or group of fiber nodes. A typical installation will have dozens of CDMA sectors with their associated HIC units connected to dozens of fiber nodes. Each HIC at the headend can host multiple CMI units distributed on the cable strands with typical deployments comprising 12 units. The specific number of CMIs per HIC will be determined by the desired coverage for the CDMA sector in question. Each HIC can have a different number of CMIs associated with it.

Figure 2-2 shows a detailed interconnection diagram for the CMI and HEE.





Notes: Only one HIC is shown for clarity.

Figure 2-2 V1.9 CMI and HEE External Interconnections

2.3 Frequency Plan

As shown in Figure 2-3, the cable plant distributes the PCS signals at an intermediate frequency along the cable infrastructure. The frequency is multiplexed with the video CATV carriers on a non-interfering basis. The intermediate frequencies used are different from the final radiated and received PCS frequencies. The CMI acts as a remotely controlled frequency translator between the PCS frequencies and the cable plant frequencies. The HIC acts as an interface between the BTS equipment frequencies and the cable plant frequencies.

Downstream, from the BTS to the mobile subscribers, PCS frequencies are 1930.0 to 1990.0 MHz. Upstream, from the mobile subscribers to the BTS, PCS frequencies are 1850.0 to 1910.0 MHz. Downstream CATV frequencies are 450.0 to 750.0 MHz. Upstream CATV frequencies are 5.0 to 52.0 MHz. The PCS and CATV frequencies may change between installations. The CMI/HIC communications link allows for dynamic adjustment of downstream and upstream CATV signal levels, so as to provide end to end gain stability.

Nominal PCS power levels shown in Figure 2-4 reflect the CATV network losses and the need for gain and attenuation from the HICs and CMIs for the PCS and CATV environments to co-exist.

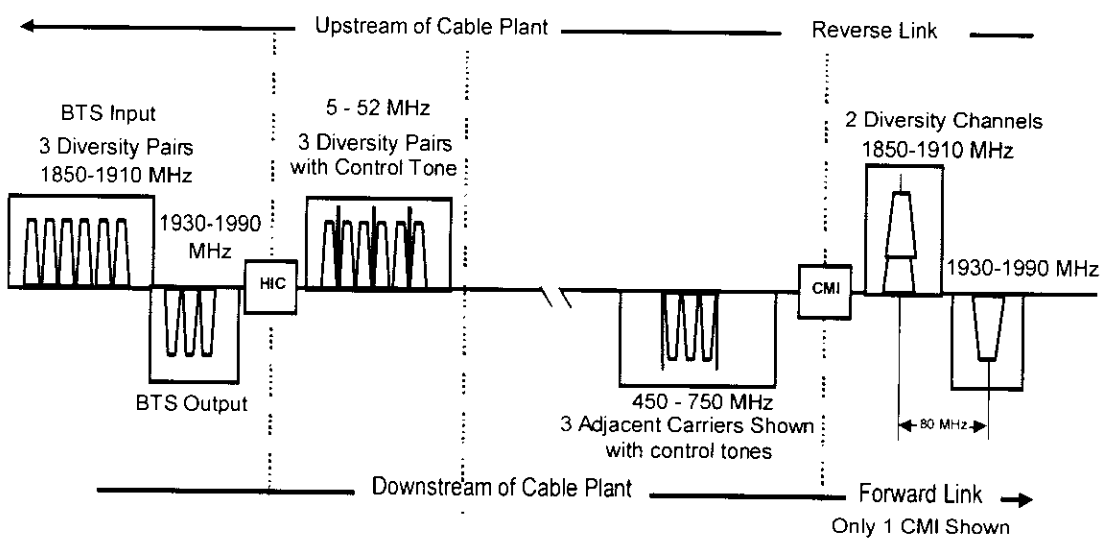


Figure 2-3 Frequency Plan

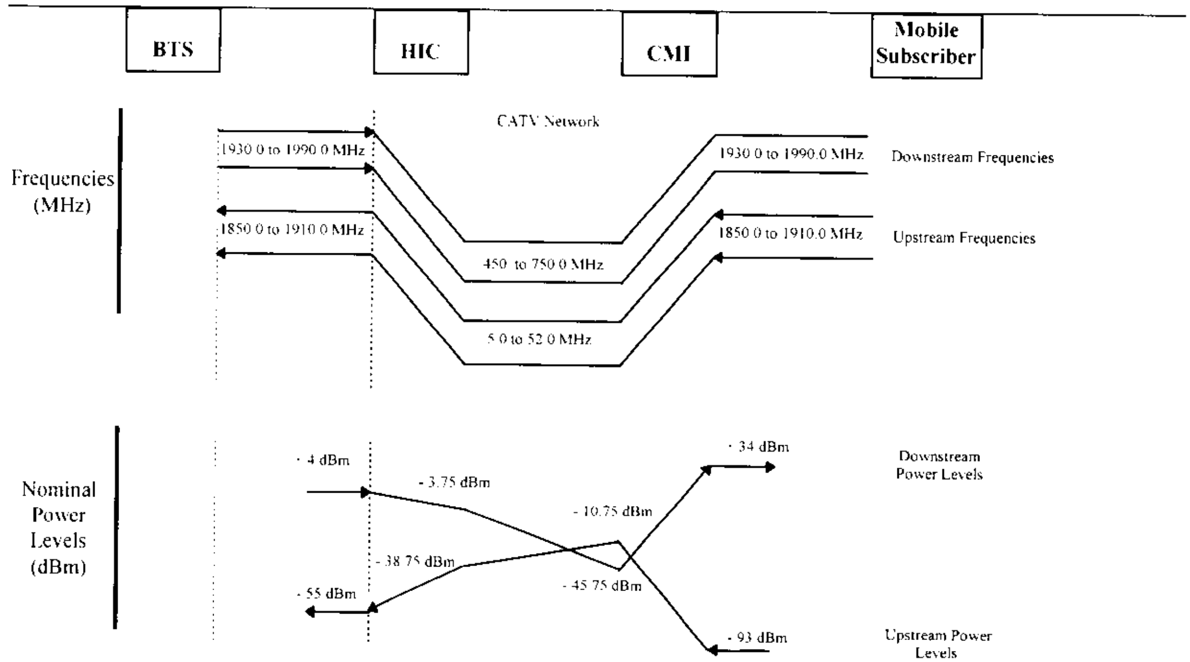


Figure 2-4 PCS-over-Cable Frequencies and Power Levels

2.4 CMI Description

The CMI is a single enclosure, incorporating an RF transceiver (with digital control circuitry), power amplifier, power extractor, and power supply. It is installed on the cable TV strand near subscriber facilities and taps into the cable, in a manner similar to existing CATV line amplifiers. The CMI is connected to three collocated antennas. One antenna transmits a CDMA-modulated signal to the subscriber's low power handheld PCS device on a frequency within the 1930-1990 MHz band. The rated transmitter power is 2.5 watts average minimum, 3.2 watts average maximum. The other two antennas receive CDMA-modulated signals from the subscriber's device in the range of 1850-1910 MHz. (Two receive antennas are used to provide spatial diversity).

In the upstream direction, the CMI translates PCS diversity receive carriers to frequencies in the CATV sub-low band (5 MHz to 52 MHz). The CDMA diversity receive carriers and their associated control carrier(s) are tunable anywhere within the 5-52 MHz band, with a step size no greater than 250 kHz. The CDMA diversity pair occupy a total of 4 MHz of upstream bandwidth, with a 2-MHz center frequency spacing within a CDMA diversity pair.

RF signals from the head end are sent downstream using an existing cable channel in the 450-750 MHz range. The CMI tunes to a downstream CDMA PCS carrier which is mapped within the traditional CATV 6-MHz channels according to any of the three EIA channel allocation plans: Standard, Harmonically Related

Carriers (HRC) or Incrementally Related Carriers (IRC). A maximum of three CDMA carriers may be mapped into a single 6 MHz CATV channel. The CMI upconverts the downstream signal for transmission via the antenna on one of the assigned PCS frequencies mentioned above. The CMI processes only one carrier within the three carrier channel.

The CMI utilizes a downstream CW frequency reference carrier and a control carrier embedded within the three carrier CATV channel.

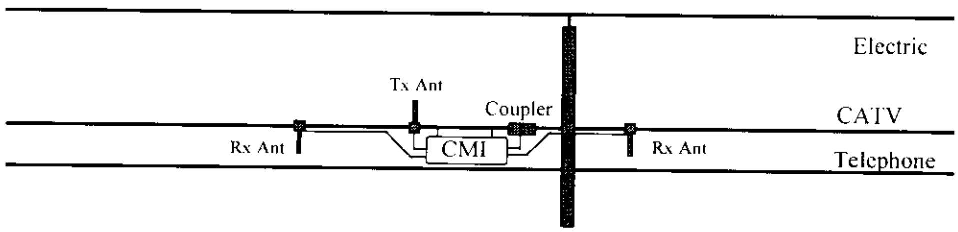


Figure 2-5 Typical CMI Installation

The CMI does not use electric utility power. It uses AC power at a nominal 60 V_{rms}, 60 Hz (clipped sinewave), supplied from a dedicated power source which is transmitted on the CATV cable along with the RF signals. The AC voltage range is 45 to 90 VRMS.

This particular CMI hardware configuration allows transmit coverage for all PCS blocks. Three unique CMI/HIC hardware sets cover the PCS band as follows:

PCS Blocks	Transmit Tuning Range	CMI and HIC Part Numbers		FCC ID
A and D	1931.25–1943.75 and 1946.25-1948.75	CMI	8334655G1 8334655G2 8334655G3	L5H94117V190A
		HIC	8334760G1	
B and E	1951.25–1963.75 and 1966.25-1968.75	CMI	8334655G4 8334655G5 8334655G6	L5H94117V190B
		HIC	8334760G2	
C and F	1971.25–1973.75 and 1976.25-1988.75	CMI	8334655G7 8334655G8 8334655G9	L5H94117V190C
		HIC	8334760G3	

The PCS band of operation is not reconfigurable by the CATV operator or maintainer. The transmitting frequency is selectable by the operator to 50 kHz spaced channels within the designated blocks. Transmit center frequencies within 1.25 MHz from each PCS block edge are locked out by software. Frequency accuracy (nominally $5x10^{-8}$) is governed primarily by performance of the frequency reference tone from the HIC, which is the reference for multiple phase-lock-loops used within the CMI.

2.5 HIC Description

Several CMIs within a particular sector are controlled by the HIC. The main function of the HIC is to provide a communications interface between individual CMIs and the Base Transceiver Station (BTS) located in the cable head end. The HIC does not connect to an antenna. Each HIC can control multiple CMIs.

The HIC converts up to three CDMA PCS carriers supplied from the BTS at PCS frequencies (between 1930 and 1990 MHz) to a selectable downstream CATV channel (between 450 and 750 MHz). The HIC also converts up to three upstream CATV carriers (between 5 and 52 MHz) from multiple CMIs to the appropriate BTS frequency range (between 1850 and 1910 MHz). The HIC generates a downstream CW frequency reference carrier and a control carrier embedded within the three-carrier CATV channel. Spurious signals related to any signals output from the CATV output of the HIC do not exceed -53 dBc as referenced to the level of the adjacent VSBAM video carrier in the passband from 52.7527 MHz to 750.0125 MHz.

The HEE contains the HICs, power supplies, a personal computer, and monitor. A fully loaded V1.9 HEE (with expansion rack) can accommodate up to 26 HICs, although V1.9 systems will typically use fewer HICs. Refer to Figure 2-6.

The computer and monitor within the HEE, along with the operating software constitute the HECU operator interface. Each HIC connects to the computer via an RS-485 or a RS-232 bus, which permits the head end operator or a remote network operator to control system functions. Specific operator-selectable functions include:

- Tune CMI transmit frequency
- Tune upstream channel
- Tune downstream channel
- Set CMI and HIC gain
- Enable or disable specific CMI RF transmitter.
- Report CMI RF output power level.

- Status/BIT requests
- Enable/disable specific CMI(s)

The V1.9 HEE operates on standard 115 VAC 60 Hz power, or 24 VDC power supplied from headend sources.

2.6 System Interfaces

A list of CMI/HIC external interface signals is provided in Table 2-1.

Unit	Interface Description	To/From
CMI	CATV Power & RF (2)	CATV Line Coupler
CMI	RF Out	Transmit Antenna
CMI	RF In (2)	Receive Antenna
HIC	Downstream RF Out	CATV plant
HIC	Upstream RF In (3)	CATV plant
HIC	CDMA RF In (3)	BTS
HIC	CDMA RF Out (6)	BTS
HIC	Serial Data	HECU (computer)
HIC	Power	+ 24 VDC supply
HIC	10/15 MHz Ref In	CATV plant

Table 2-1 CMI/HIC Interfaces

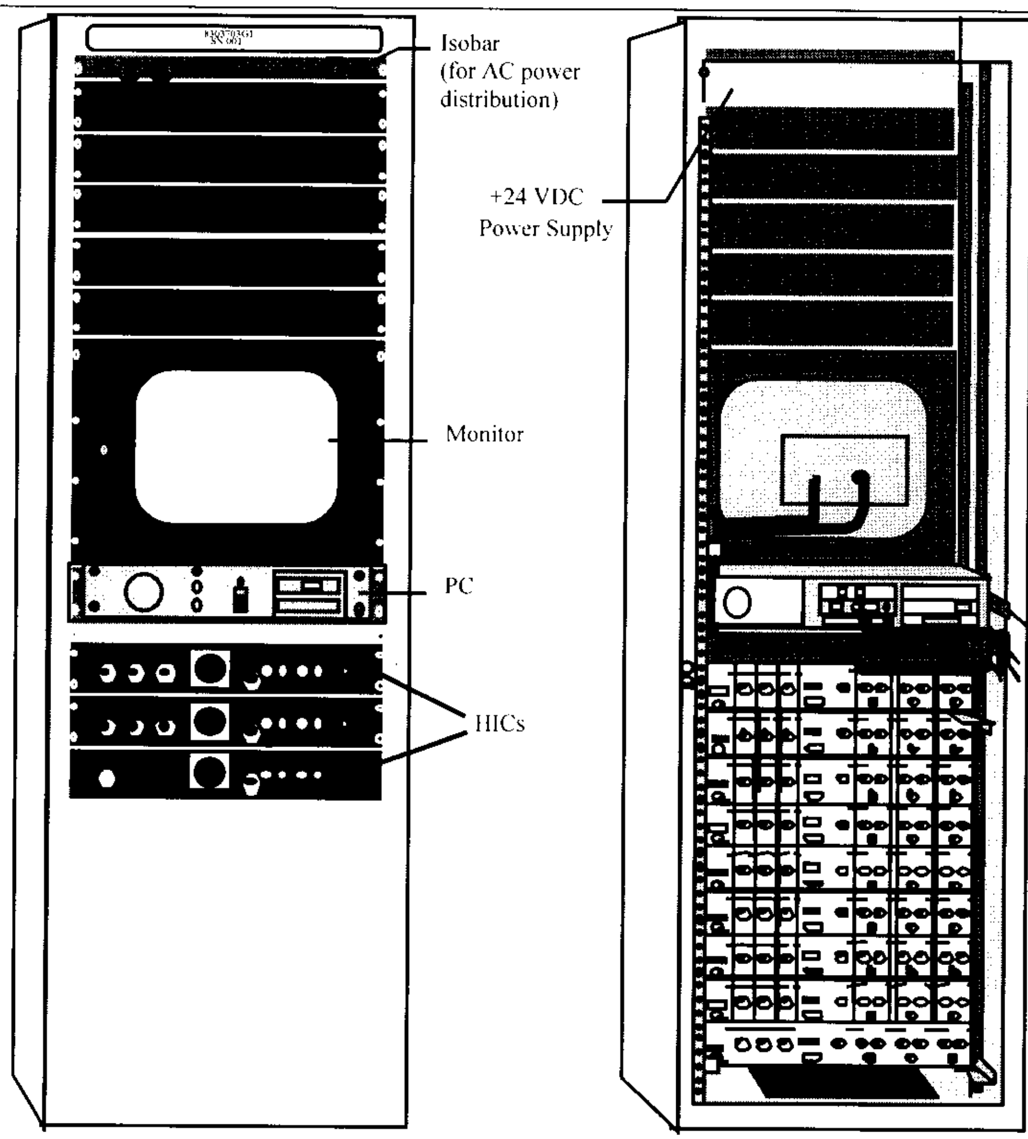


Figure 2-6 HEE Configuration

3. EXHIBIT 3 SYSTEM TEST CONFIGURATION

3.1 Test Requirements

The CMI and HIC are subject to emissions limits defined in Part 24 for Broadband PCS. Part 15 Class A limits apply to all other elements within the HEE. Refer to attached FCC correspondence.

Since the CMI derives its power from dedicated cable plant sources, and does not utilize public utility AC power, it did not undergo power line conducted emissions testing. Although the HEE is normally installed in the cable head end using a dedicated cable plant power source, it may be connected to public utility power. The HEE was therefore tested for power line conducted emissions per ANSI C63.4-1992.

Table 3-1 summarizes the FCC requirements.

CMI			
Requirement	**Limits**	**CFR §**	**Authorization Procedure**
Power Output	100 watts peak output, 1640 watts peak EIRP	24.232 and 2.985	Type Acceptance
Modulation	None	2.987	Type Acceptance
Occupied Bandwidth	stay within authorized frequency block	2.989	Type Acceptance
Frequency Stability	keep fundamental within authorized frequency block, under variations of supply voltage and temperature	24.235 and 2.995	Type Acceptance
Radiation Hazard	maximum permissible exposure per ANSI C95.1 1.3 mW/cm^2 uncontrolled env't, 6.4 mW/cm^2 controlled env't	24.52	Type Acceptance
Spurious/Harmonic Emissions, Transmitter Output	less than -13 dBm from lowest RF to 19.9 GHz, outside of authorized block	24.238 and 2.991	Type Acceptance
Spurious Radiated Emissions	equiv to 5000 uV/m at 10m, from lowest RF to 19.9 GHz	24.238 and 2.993	Type Acceptance
HEE			
Requirement	**Limits**	**CFR §**	**Authorization Procedure**
Spurious Radiated Emissions (HIC only)	equiv to 5000 uV/m at 10m, from lowest RF to 19.9 GHz	24.238 and 2.993	Type Acceptance
Radiated Emissions (other than HIC)	90 uV/m, 30-88 MHz 150 uV/m, 88-216 MHz 210 uV/m, 216-960 MHz 300 uV/m, 960 to 5 times highest RF, MHz	15.109(b)	Verification (limits apply at 10 meters)
Conducted Emissions, Power line	1000 uV, 450 to 1705 kHz 3000 uV, 1.705 to 30 MHz	15.107(b)	Verification

Table 3-1 FCC Test Requirements

FEDERAL COMMUNICATIONS COMMISSION

Customer Service Branch
7435 Oakland Mills Road, Columbia, MD 21046
Phone: (301) 725-1585, ext 221 Fax: (301) 344-2050
FROM: Hugh L. Van Tuyl **DATE:** July 26, 1995
TO: Michael Prussel, Sanders
PAGES: One
REFERENCE: Your letter dated July 5, 1995
FAX NUMBER: (603) 885-2919

Dear Mr. Prussel:

This is in response to your letter dated July 5, 1995 to Mr. Richard Engelman. You asked about the requirements for Part 24 PCS equipment. The following responds to your questions in the order that they were presented.

1. If the equipment will be type-accepted under Part 24 of the rules, then the requirements for unlicensed intentional radiators in Subpart C of Part 15 do not apply.

2. Section 15.3(k) is not intended to exempt digital circuitry from compliance with all technical standards. Digital circuitry contained in a device subject to standards other than Part 15 must comply with those standards. Accordingly, the RAD, including the digital circuitry, must comply with the Part 24 emission limits.

3. The receiver contained in your device, which tunes in the range of 1850-1910 MHz, is not subject to the Part 15 limits since it operates above 960 MHz.

4. Based upon our understanding of this device, both the RASP and the RAD can be considered portions of a single Part 24 transmitter, despite the fact they may be located miles apart. Therefore, they can be type-accepted as one device under a single FCC ID. If the digital circuitry in the RASP has functions other than controlling the transmitter, it must be verified for compliance as a Class A digital device. Otherwise, pursuant to Section 15.3(k), it must meet the Part 24 limits.

If you have any additional questions, please do not hesitate to contact me.

TOTAL P.02

3.2 Test Facility

Radiated emissions and powerline conducted emissions tests were performed at the site of Quest Engineering Solutions, Billerica, MA. Antenna conducted emissions tests were performed at Sanders MAN-6 facility.

3.3 Test Methodology

RF emissions tests were performed in general accordance with ANSI C63.4-1992.

3.4 Test Configuration Details

3.4.1 CDMA Input Signal Description

For all tests, a CDMA waveform generator was used to simulate input from the headend BTS. The signal generator used was a NoiseCom CDMA signal source, model CDMA-1900-1. This generator outputs a noiselike waveform having a 3 dB bandwidth of 1.25 MHz about the center frequency, and a crest factor (ratio of peak to average output power) of about 12 dB, which is designed to mimic that of a "fully loaded" CDMA forward signal. The CDMA signal meets the spectral shape and purity requirements of existing PCS CDMA specifications. However, the NoiseCom generator emulates the spectral characteristics of the actual BTS CDMA waveform, but not the time domain characteristics.

The generator was set to the appropriate frequency (same as the CMI transmit frequency). The level was set to +5 dBm (average), which is consistent with the maximum output of a conventional Base Transceiver Station (BTS) interface. The forward signal was injected into the system by splitting the signal and injecting it into the three HIC input ports (alpha, beta, and gamma).

Since the NoiseCom faithfully reproduces the CDMA spectral shape and width, there is no difference in the CMI transmitted occupied bandwidth between use of this generator vs. actual operation.

However, it should be noted that the NoiseCom generator is not continuously tunable, but center frequency is adjustable only in 100 kHz increments. The PCS standard employs a 50 kHz channel spacing. In the case of PCS transmit channels at the extreme high or low end of the block, the NoiseCom could not be centered exactly on the PCS channel. Therefore, for conducted spurious testing, the next adjacent valid PCS channel was used (in A-block for example, the channel centered at 1931.30 was used, instead of the extreme edge channel centered at 1931.25). The occupied bandwidth plots of Exhibit 4 shift the limit inward by 50 kHz to compensate. As can be seen in the plots, this 50 kHz shift does not result in violation of the Part 24 spurious emissions limits.

3.4.2 CMI Configuration, Transmitter Output Tests

Refer to Figure 3-1.

3.4.2.1 Simulation of Cable Plant Loading

For antenna conducted spurious tests, simulated CATV video carriers were injected into the CATV downstream path along with the downstream CDMA signal. The carriers were six TV signals, spaced 6 MHz apart, starting at channel 84 (582 MHz) and ending at channel 90 (619 MHz). The nominal video signal level of each carrier was set to 15 dBmV. The downstream CDMA carrier was set to channel 87 (601 MHz) at a level of 0 dBmV.

3.4.3 CMI Configuration, Radiated Emissions

For radiated emissions tests, a wooden test fixture was employed to simulate actual CMI installation. The fixture used a length of horizontal cable strand, raised approximately two meters above the ground plane. The entire fixture was placed on a flush-mounted turntable. Refer to Figure 3-2. Typical system antennas were mounted on the simulated strand. All three antennas were identical vertically polarized dipoles, having a frequency range of 1850 - 1990 MHz. The two CMI receive ports were connected to the antennas. The transmit port was connected to an RF load. The transmit antenna was not connected for the radiated emissions tests for the following reasons:

1. Concern that CMI RF transmissions might interfere with neighboring PCS systems (significant local activity in the PCS band was observed during ambient scans).
2. Simpler measurement configuration (no external filtering required on the spectrum analyzer)
3. Emissions from the transmit antenna port are well characterized in the conducted spurious tests.

3.4.4 HEE Configuration

The HEE was tested per ANSI C63.4 requirements for floor standing devices. Each HIC and HECU port was connected to a cable. To ensure a worst-case cable configuration, the bulk of the rack cables were extended horizontally for about 50 cm, before being dropped vertically to the ground plane. See Table 3-2 and Figure 3-3.

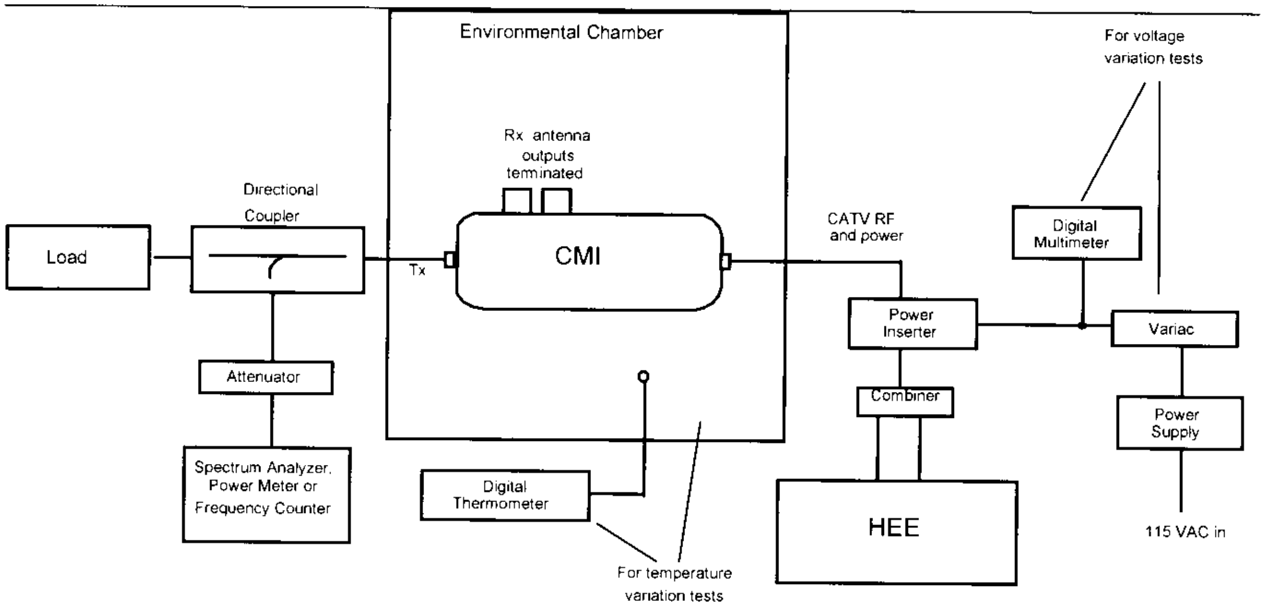


Figure 3-1 Setup for Transmitter Output Tests

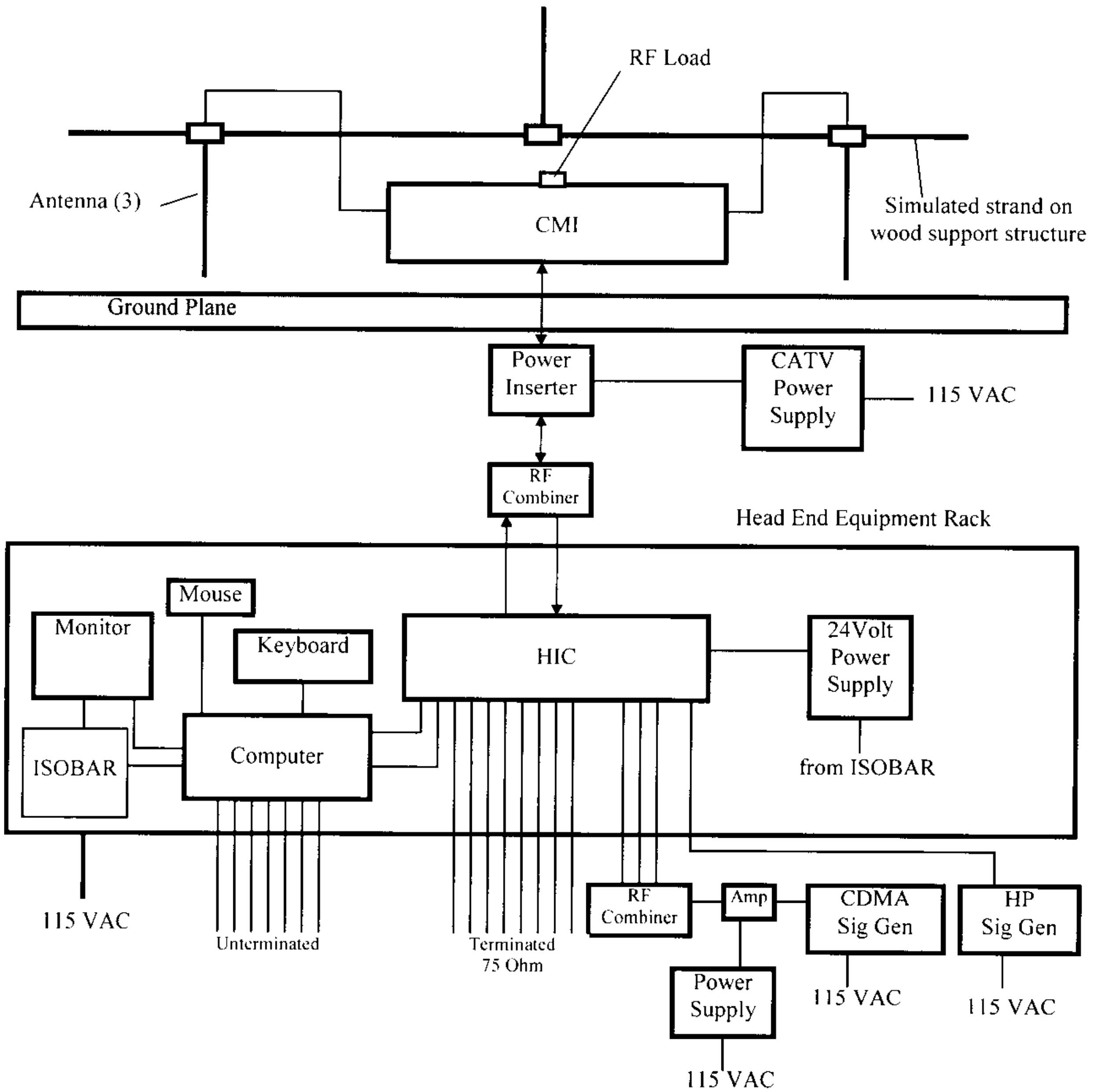


Figure 3-2 CMI Radiated Emissions Test Setup

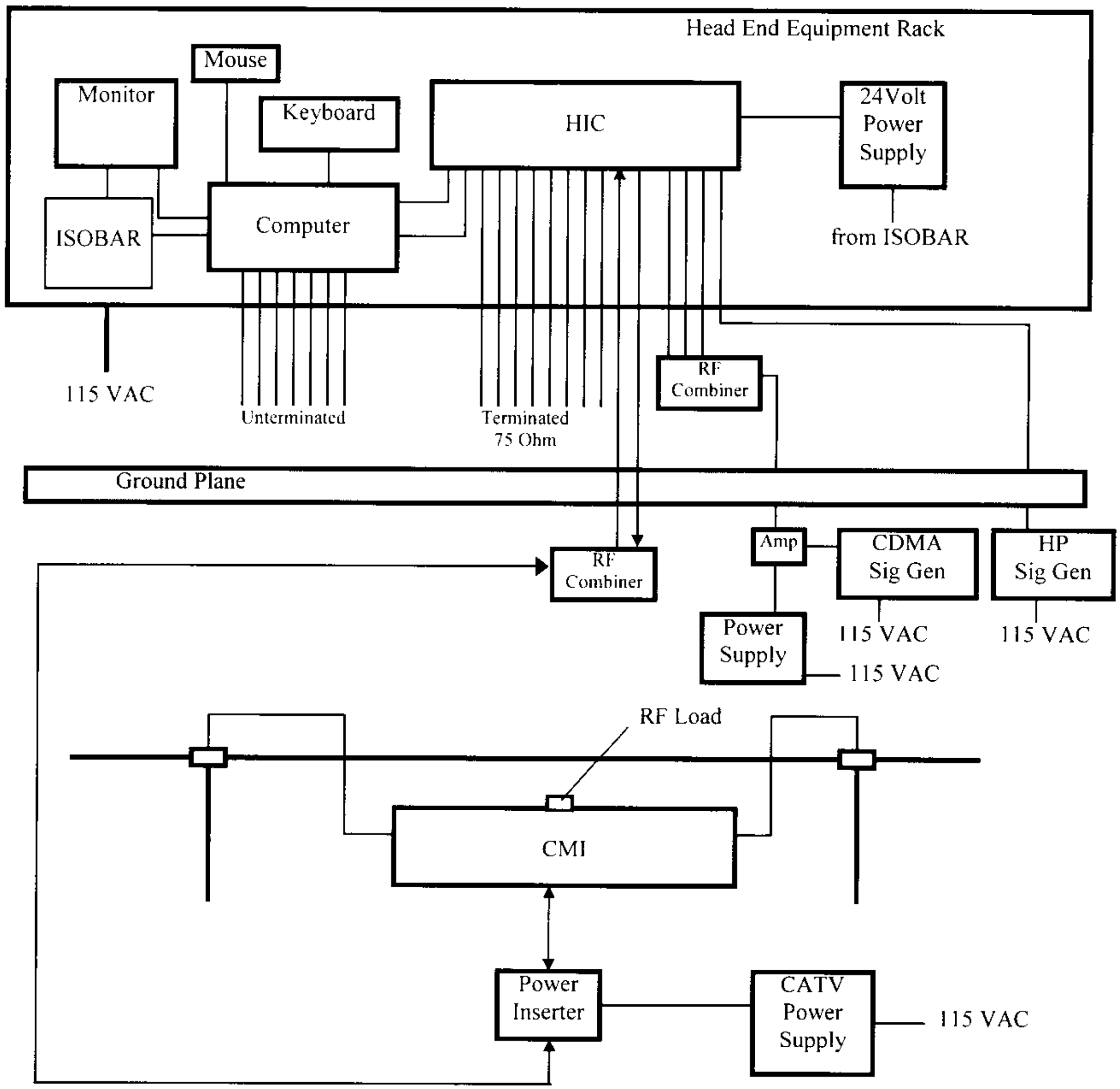


Figure 3-3 HEE Radiated Emissions Test Setup

Interface	Cable Qty	Type	Approximate Length	Comment
CMI				
CMI Antennas	2	RG-223	2.5 ft.	Transmit antenna port terminated 50 ohms
CMI Power & RF	1	RG-59	25 ft.	
HIC				
HIC Serial Data (RS-485)	1	twisted pair	6 ft.	
HIC Serial Data (RS-232)	1	Shielded group	6 ft.	
HIC 24V Power	1	twisted pair	4 ft.	
HIC CATV output (forward)	1	RG-59	25 ft.	
HIC CATV input (reverse alpha)	1	RG-59	25 ft.	
HIC CATV input (reverse beta, gamma)	2	RG-59	4 ft.	Terminated 75 ohms
HIC 15 MHz Ref	1	RG-223	25 ft.	
HIC input from BTS	3	RG-223	4 ft.	To NoiseCom via combiner
HIC output to BTS	6	RG-59	4 ft.	Terminated 75 ohms

Table 3-2 Interconnecting Cable Description

Item	Mfr.	Model/Serial #	FCC ID
CMI (A/D Band)	Sanders	969T12M10020	L5H94117V190A
CMI (B/E Band)	Sanders	969T12M10032	L5H94117V190B
CMI (C/F Band)	Sanders	969T12M10049	L5H94117V190C
CMI Antennas	Antenna Specialists	ASPM2973COX	---
HIC (A/D Band)	Sanders	989T02910002	L5H94117V190A
HIC (B/E Band)	Sanders	989T02920001	L5H94117V190B
HIC (C/F Band)	Sanders	989T02930002	L5H94117V190C
Power Supply, 24 VDC	HC Power	RK-C1272	---
Computer	Global American	QT5357	---
Mouse	Logitech	LZB63508510	DZLM04
Keyboard	Cherry	MY1800	GDD5Y0G80-1800
Power Distribution Unit	TrippLite	Isobar IBR-12	---
Monitor	CTX	1451C	DBL1451C

Table 3-3 Identification of Equipment Under Test

Description	Model/Mfr.
Spectrum Analyzer	8593E/HP
Spectrum Analyzer	8566B/HP
Quasi-Peak Adapter	85650A/HP
RF Preselector	85685A/HP
Power Meter	436A/HP
Power Sensor	8481B/HP
Rod Antenna	VA-105/EMP
Biconilog Antenna	3143/EMCO
DRG Antenna	96001/Eaton
LISN	EMCO
Signal Generator	2024/Marconi
Signal Generator	8657B/HP
Power Supply	FLP Type 3/PowerGuard
Power Supply	FRP-9015-0/PowerGuard
Power Inserter	RPI-100/Regal
CDMA Generator	CDMA-1900-1/NoiseCom
Video Modulators	FAVM 360/Blonder Tongue
Attenuator	46-20-34/Weinschel
Directional Coupler	4222-16/Narda
50 Ω Termination	TRM-2143-MO-SMA-07
Variac	146/ PowerStat
Digital Multimeter	77/Fluke
Plotter	7550A/HP

Table 3-4 FCC Test Equipment and Exercise Equipment

3.5 Justification for Selected Test Configuration

EUT Height. The CMI is designed to be installed on the CATV strand, and thus the actual EUT height above ground level is nominally 23 feet. A lower height of 2 meters was chosen to allow good elevation coverage by the measurement antennas. In addition, the 2 meter height corresponds to documented site attenuation data.

Strand Length. The actual length of interconnecting coaxial cable cannot obviously be duplicated. In order to simulate actual antenna installation, approximately six feet of strand length was used. This provided ample length to install the CMI antennas. The extra length on either side ensured that the CMI antenna patterns were close to what would be expected in a real installation.

HIC Quantity. As previously mentioned, each HEE has space for up to 13 HICs. For FCC testing, only one HIC was used, due to limited availability of production hardware. Measured radiated emissions data presented in Exhibit 4 show the worst-case emissions from a single HIC are at least 25 dB below the applicable Part 24 limit. Therefore it can be inferred that if even a full-up rack were tested, the aggregate emissions profile would still be within Part 24 limits, assuming in-phase summation of emissions from each HIC at any given frequency.

3.6 EUT Exercise Software

Three items of software were employed for FCC testing:

- CMI operational software. From previous production system.
- HIC operational software. From previous production system.
- HECU software. A Sanders-developed software program called Personal Communications Message Simulator (PCMS) was used for the operator interface. This program provided the flexibility to manually vary relevant system parameters (i.e. PCS channels, CATV channels, transmit channels, attenuation levels) in order to obtain worst-case emissions test profiles. Test results as reported herein are expected to be identical with production HECU operating system software. The draft operators manual found in Exhibit 8 contains a detailed description of the operating software.

3.7 Special Accessories

A shielded cable is required for the RS-232 interfaces connecting to the computer, in order to comply with Part 15 Class A limits. No other special accessories are required for FCC compliance. Appropriate user information will be included in the final installation manual.

3.8 Equipment Modifications

During the course of FCC final compliance testing, the following modifications were made to the CMI/HEE hardware configuration:

- Shielded interface cable for HIC RS232 interface. The requirement will be specified in the final installation manual.

- Bypass capacitor on CMI transceiver card (to suppress leakage of 2 x LO7 through the power amplifier). Fix is incorporated into production circuitry.

4. EXHIBIT 4 TEST RESULTS

4.1 Signatures

I certify that I have performed, witnessed, or supervised these FCC tests, and that the data presented herein are true and complete.

Michael Prussel
EMC Engineer
NARTE EMC-001019-NE

4/30/98
Date

4.2 Power Output

4.2.1 Test Procedure

Tests were performed in general accordance with ANSI C63.4-1992. The CDMA generator was used to simulate actual system modulation. Average power was measured directly with the power meter.

The peak power output data were obtained by connecting the transmitter output to a directional coupler and RF load. The coupled port was connected to the spectrum analyzer. A 30 kHz RBW setting was used, and the analyzer was set to peak hold mode.

4.2.2 Instrumentation Used

Description	Tag No.	Model/Mfr.	Cal. Date
Spectrum Analyzer	96219	8593E/HP	5/12/97
Power Meter	41032	436A/HP	9/2/97
Power Sensor	206059	8481B/HP	6/17/97
Attenuator	211806	46-20-34/Weinschel	7/9/97
Coupler	208281	4222-16/ Narda	3/13/98
Load	---	TRM-2143-MO-SMA-07 Midwest Microwave	---

4.2.3 Results

Average power as measured with the power meter is tabulated in column 3 of the table below. The raw spectrum analyzer levels are recorded in column 4. Setup loss in dB is recorded in column 5. Column 6 is the bandwidth adjustment factor, which is necessary to account for the reduction in signal amplitude when using the 30 kHz resolution bandwidth.

Bandwidth correction = $10\log\left[\frac{1.23MHz}{0.03MHz}\right]$ = 16.1 dB.

The peak power in dBm of column 7 was obtained by adding columns 4, 5 and 6. The power in dBm was converted to power in watts by:

P = antilog((D-30)/10)

where: P = power in watts
D = power in dBm

The CMI complies with Part 24 requirements for peak power output when connected to representative system antennas.

Channel	Center Frequency, MHz	Average Power, dBm [1]	Average Power, watts	Analyzer Reading, dBm [2]	Cable and Coupler Loss, dB	Bandwidth Adjustment Factor, dB [3]	Peak Power, dBm	Peak Power, watts
26	1931.30	35.1	3.2	-11.9	37.8	16.1	42.0	15.8
150	1937.50	35.1	3.2	-11.4	37.8	16.1	42.5	17.8
274	1943.70	35.1	3.2	-11.9	37.8	16.1	42.0	15.8
326	1946.30	35.1	3.2	-11.9	37.8	16.1	42.0	15.8
374	1948.70	35.1	3.2	-11.6	37.8	16.1	42.3	17.0

[1] measured with power meter.
[2] measured with spectrum analyzer in peak, max hold mode, 30 kHz RBW.
[3] Bandwidth factor of 16.1 dB is obtained from $10 \cdot \log(1.23/0.03)$.

4.3 Occupied Bandwidth

4.3.1 Test Procedure

Tests were performed in accordance with ANSI C63.4-1992. The CDMA generator was used to simulate actual system modulation.

4.3.2 Instrumentation Used

Description	Tag No.	Model/Mfr.	Cal. Date
Spectrum Analyzer	96219	8593E/HP	5/12/97
Attenuator	211806	46-20-34/Weinschel	7/9/97
Coupler	208281	4222-16/ Narda	3/13/98
Load	---	TRM-2143-MO-SMA-07 Midwest Microwave	---

4.3.3 Results

Measured occupied bandwidth was 1.375 MHz at the 26 dB down points for all channels tested. At the extreme upper and lower CMI channels, the transmitted signal is well within the PCS block limits. Figures 4-1 through 4-4 shows occupied bandwidth of the four channels at the edges of each PCS block. The Part 24 emissions limit is superimposed on each chart.

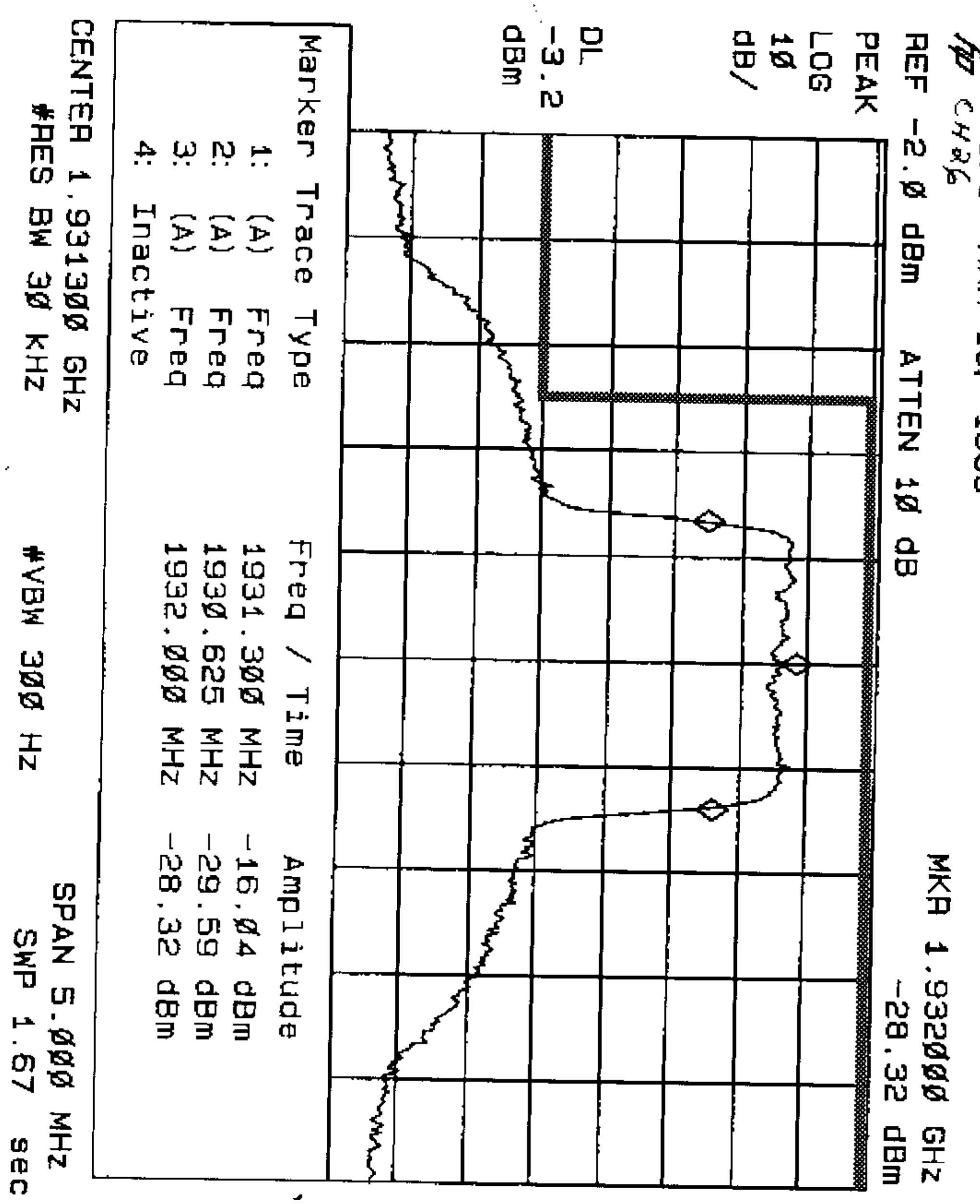


Figure 4-1 Occupied Bandwidth, Channel 26

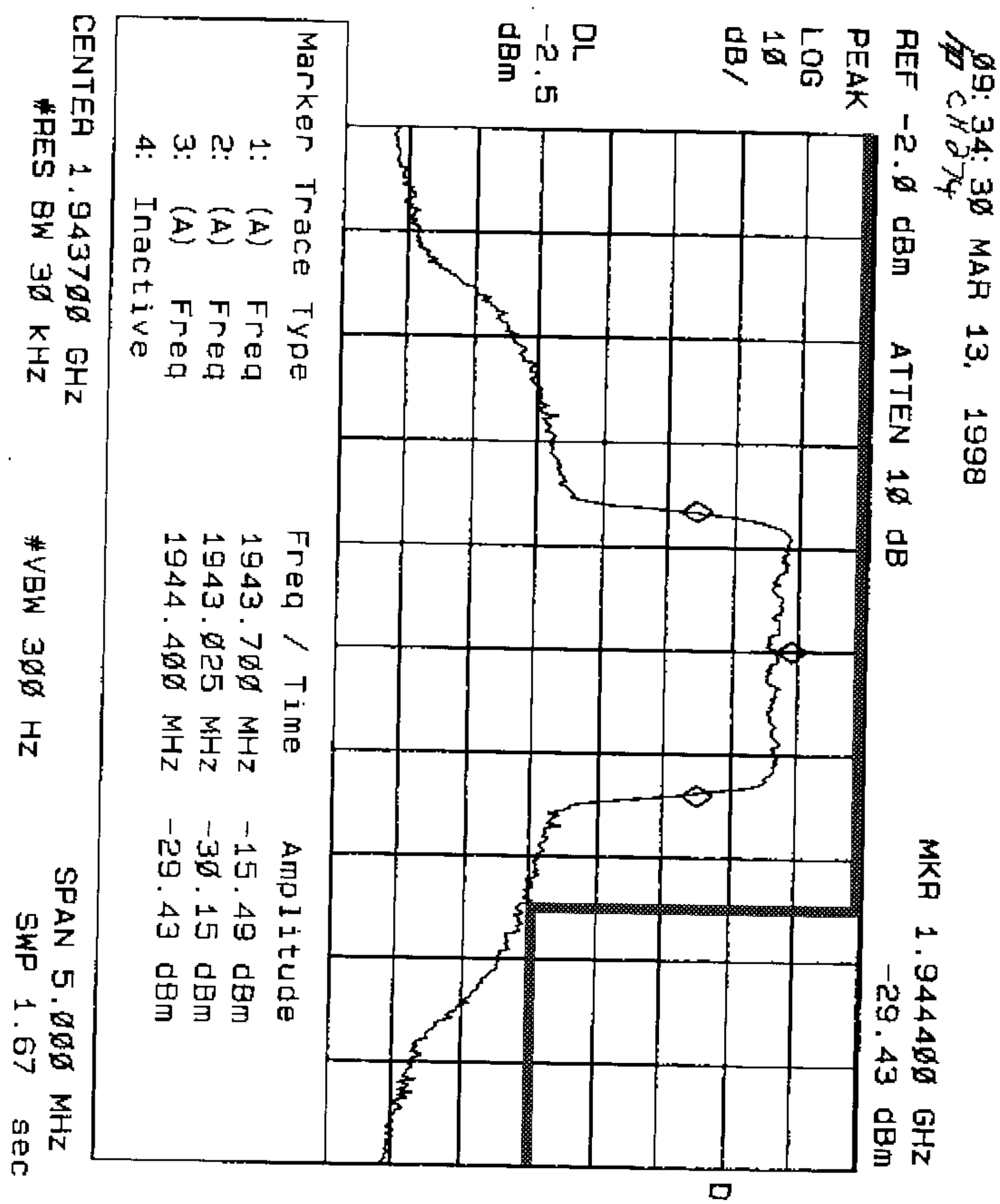


Figure 4-2 Occupied Bandwidth, Channel 274

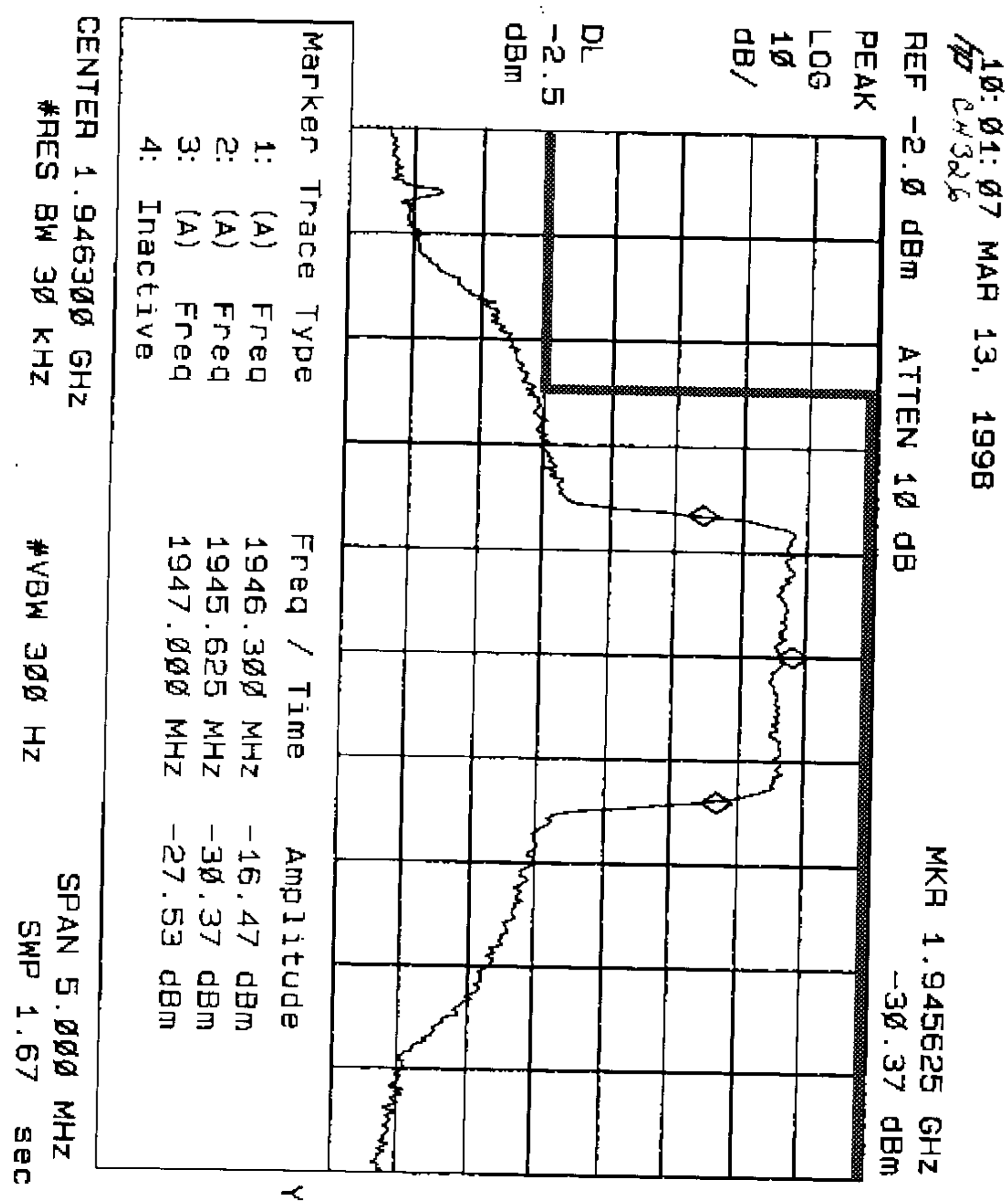


Figure 4-3 Occupied Bandwidth, Channel 326

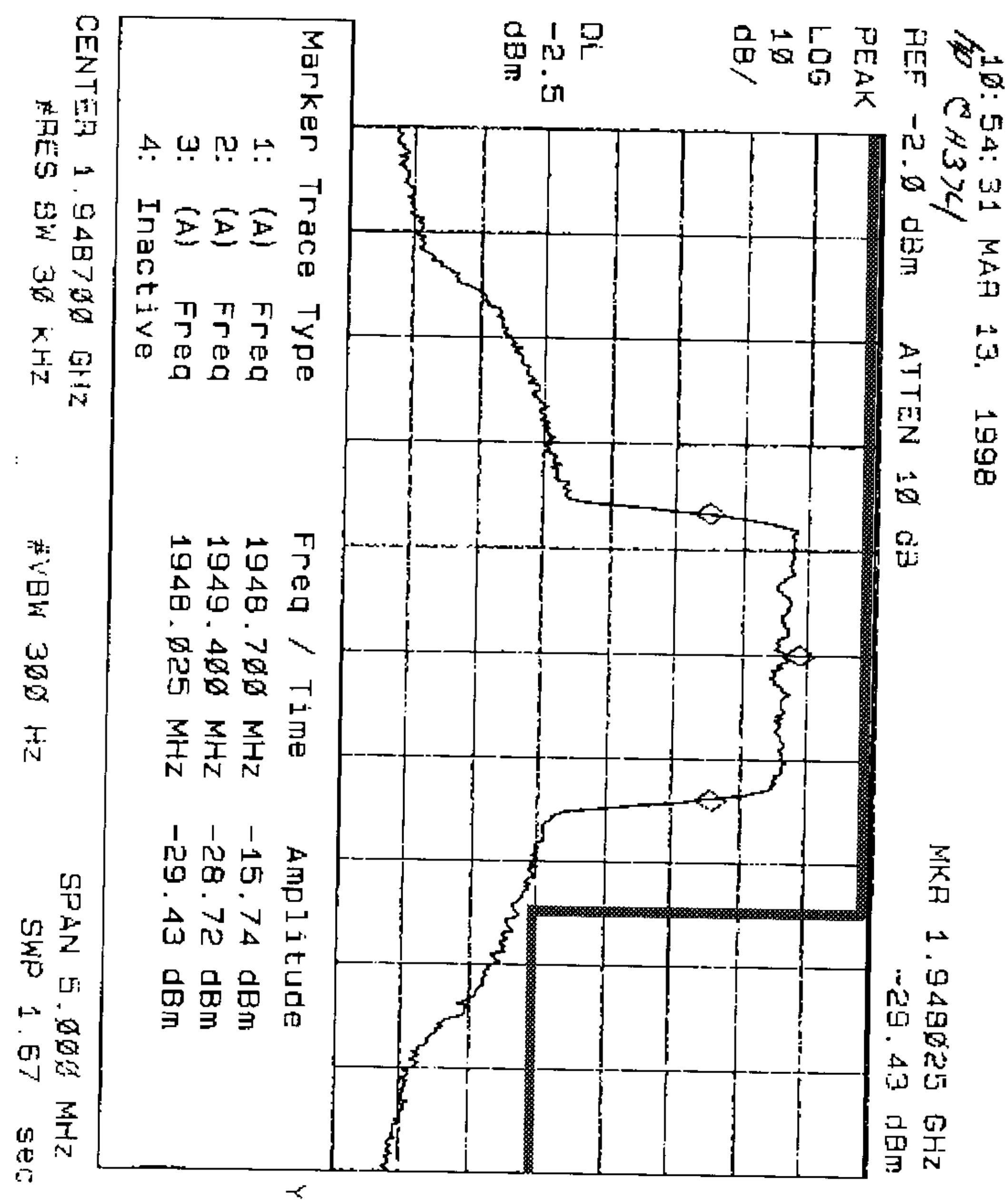


Figure 4-4 Occupied Bandwidth, Channel 374

4.4 Spurious Emissions at Antenna Terminals

4.4.1 Test Procedure

Tests were performed in accordance with ANSI C63.4-1992. Per CFR 24.238, all measurements above 1 GHz were performed using average detection and a 1 MHz resolution bandwidth, except at measurement frequencies within the PCS block and 1 MHz beyond the upper and lower PCS block edges, where a 30 kHz resolution bandwidth was used. All measurements below 1 GHz were performed using peak detection and bandwidths per ANSI C63.4-1992.

Tests were performed using simulated CATV video carriers in the downstream path, as described in Exhibit 3. The CMI power output level was set to the rated maximum (3.2 watts) for all measurements.

4.4.2 Instrumentation Used

Description	Tag No.	Model/Mfr.	Cal. Date
Spectrum Analyzer	96219	8593E/HP	5/12/97
Power Meter	41032	436A/HP	9/2/97
Power Sensor	206059	8481B/HP	6/17/97
Attenuator	211806	46-20-34/Weinschel	7/9/97
Coupler	208281	4222-16/ Narda	3/13/98
Load	---	TRM-2143-MO-SMA-07 Midwest Microwave	---

4.4.3 Results

Per CFR 24.238, out-of-block emissions are required to be a minimum of $43 + 10 \cdot \log(P)$ below the fundamental power, where P is the transmitter power in watts. In terms of an absolute power level, the limit is calculated by:

$$P_{lim} = 10 \cdot \log(P) - (43 + 10 \cdot \log(P)) = -43 \text{ dBW} = -13 \text{ dBm}.$$

All emissions were below the required limit. The highest measured levels are tabulated below. In addition, the occupied bandwidth plots presented in Figures 4-1 through 4-4 show that Part 24 limits are met for PCS transmit channels at the edge of the block.

CMI Transmit Channel (Center Freq)	Spurious Emission Frequency, MHz	Detected Amplitude, dBm	Setup Insertion Loss, dB	Spurious Emission Amplitude, dBm	Part 24 Limit, dBm
Channel 26 (1931.30 MHz)	936.20	-73.9	37.5	-36.4	-13.0
	5793.85	-61.3	39.6	-21.7	-13.0
Channel 150 (1937.50 MHz)	945.45	-72.8	37.5	-35.3	-13.0
	5812.35	-61.8	39.6	-22.2	-13.0
Channel 274 (1943.70 MHz)	954.79	-74.3	37.5	-36.8	-13.0
	5831.00	-62.2	39.6	-22.6	-13.0
Channel 326 (1946.30 MHz)	958.70	-72.5	37.5	-35.0	-13.0
	5838.90	-59.4	39.7	-19.7	-13.0
Channel 374 (1948.70 MHz)	962.22	-73.4	37.5	-35.9	-13.0
	5846.10	-59.1	39.7	-19.4	-13.0

Note: all measurements were performed at a transmitter fundamental output power of 35.1 dBm (3.2 watts) average.

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4.5 Frequency Stability

4.5.1 Test Procedure

Tests were performed in general accordance with ANSI C63.4-1992. A single tone at the center of the PCS channel was injected into the HIC. A spectrum analyzer was used to record the frequency deviation. To obtain the necessary measurement precision, both the signal generator and the spectrum analyzer were locked to a common frequency reference.

Temperature tests were performed over the range of –40 to +60 °C (system operating range). Voltage variation testing was performed at the midpoint and extremes of the system operating range (45 to 90 volts rms).

4.5.2 Instrumentation Used

Description	Tag No.	Model/Mfr.	Cal. Date
Spectrum Analyzer	96221	8593E/HP	1/29/98
Digital Multimeter	209511	77/Fluke	8/24/97
Temperature Chamber	55480	EX-1104/Associated Environmental Systems	8/12/97
Autotransformer	---	146/PowerStat	---

4.5.3 Results - Input Power Variation

CMI Transmit Channel (Frequency)	Input AC Voltage, volts rms	Frequency Deviation
Channel 25 (1931.25 MHz)	45	10 Hz or less
	60	10 Hz or less
	90	10 Hz or less
Channel 150 (1937.50 MHz)	45	10 Hz or less
	60	10 Hz or less
	90	10 Hz or less
Channel 275 (1943.75 MHz)	45	10 Hz or less
	60	10 Hz or less
	90	10 Hz or less
Channel 325 (1943.75 MHz)	45	10 Hz or less
	60	10 Hz or less
	90	10 Hz or less
Channel 375 (1943.75 MHz)	45	10 Hz or less
	60	10 Hz or less
	90	10 Hz or less

Note: Nominal line voltage is 60 volts rms.

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4.5.4 Results - Temperature Variation

CMI Transmit Channel (Frequency)	Temp, ºC	Frequency Deviation
Channel 25 (1931.25 MHz)	-40	10 Hz or less
	-30	10 Hz or less
	-20	10 Hz or less
	-10	10 Hz or less
	0	10 Hz or less
	10	10 Hz or less
	20	10 Hz or less
	30	10 Hz or less
	40	10 Hz or less
	50	10 Hz or less
	60	10 Hz or less
Channel 150 (1937.50 MHz)	-40	10 Hz or less
	-30	10 Hz or less
	-20	10 Hz or less
	-10	10 Hz or less
	0	10 Hz or less
	10	10 Hz or less
	20	10 Hz or less
	30	10 Hz or less
	40	10 Hz or less
	50	10 Hz or less
	60	10 Hz or less
Channel 275 (1943.75 MHz)	-40	10 Hz or less
	-30	10 Hz or less
	-20	10 Hz or less
	-10	10 Hz or less
	0	10 Hz or less
	10	10 Hz or less
	20	10 Hz or less
	30	10 Hz or less
	40	10 Hz or less
	50	10 Hz or less
	60	10 Hz or less

CMI Transmit Channel (Frequency)	Temp, ºC	Frequency Deviation
Channel 325 (1946.25 MHz)	-40	10 Hz or less
	-30	10 Hz or less
	-20	10 Hz or less
	-10	10 Hz or less
	0	10 Hz or less
	10	10 Hz or less
	20	10 Hz or less
	30	10 Hz or less
	40	10 Hz or less
	50	10 Hz or less
	60	10 Hz or less
Channel 375 (1948.75 MHz)	-40	10 Hz or less
	-30	10 Hz or less
	-20	10 Hz or less
	-10	10 Hz or less
	0	10 Hz or less
	10	10 Hz or less
	20	10 Hz or less
	30	10 Hz or less
	40	10 Hz or less
	50	10 Hz or less
	60	10 Hz or less

4.6 Field Strength of Spurious Radiation

4.6.1 Test Procedure

Tests were performed in accordance with ANSI C63.4-1992. CMI testing utilized guidelines for tabletop equipment, with modifications as noted in Exhibit 3. The HECU was tested per ANSI C63.4-1992 guidelines for floor-standing equipment. All measurements were performed at a 10 meter distance, except above 1 GHz, where a 3 meter distance was used. Test frequency range was 1 MHz to 20 GHz.

4.6.2 Instrumentation Used

Description	Serial No.	Model/Mfr.	Cal. Date
Spectrum Analyzer	2928A05991	8566B/HP	3/98
Quasi-Peak Adapter	2521A00745	85650A/HP	12/97
RF Preselector	2620A00342	85685A/HP	11/97
Active Monopole Antenna	103	RAM-220A/Antenna Research	3/98
Biconilog Antenna	1118	3143/EMCO	3/98
DRG Antenna	6226	RGA-60/Electrometrics	11/97
Preamplifier	3008A00252	8449B/HP	12/97
Transient Limiter	2820A00193	11947A/HP	3/98
LISN	9010-1709	EMCO	11/97

4.6.3 Results

All detected emissions from the CMI and HIC were within Part 24 limits, as shown in the table below. Emissions from HEE sources other than the HIC were within limits of CFR 15.109 for Class A devices.

Per CFR 2.993, spurious emissions levels should be expressed in terms of radiated power relative to the rated transmitter output power, assuming that all emissions are radiated from halfwave dipole antennas. Calculation of this equivalent level was done as follows:

Radiated field strength is related to the power delivered to the radiating antenna input by:

(1) $$S = \frac{P_{eq} \cdot G}{4 \cdot \pi \cdot R^2}$$

and

(2) $$S = \frac{E^2}{377}$$ (Assuming free-space, far-field conditions)

where:

S = power density, W/m^2

P_{eq} = equivalent power level, W

G = antenna gain

R = distance from antenna, m

E = field strength, V/m

Combining (1) and (2) yields:

(3) $$P_{eq} = \frac{E^2 \cdot R^2}{30 \cdot G}$$

For all measurements performed herein, either 3 meter or a 10 meter measurement distance was used. The gain of a halfwave resonant dipole is 1.64. Equation (3) then simplifies to:

$$P_{eq} = 0.183 \cdot E^2$$ (3 meter)

$$P_{eq} = 2.03 \cdot E^2$$ (10 meter)

Converting to units of dBm (dB referenced to 1 milliwatt) and dBuV/m (dB referenced to 1 microvolt per meter):

(4) $$P_{eq_{(dBm)}} = E_{dBuV/m} - 97.4$$ (3 meter)

$$P_{eq_{(dBm)}} = E_{dBuV/m} - 86.9$$ (10 meter)

Per CFR 24.238, out-of-block emissions are required to be a minimum of 43 + 10log(P) below the fundamental power, where P is the transmitter power in watts. In terms of an absolute power level,

$$P_{eq_{(dBm)}} = 10 \cdot \log(P) - (43 + 10 \cdot \log(P)) = -43\text{dBW} = -13\text{dBm}$$

Other than at the fundamental transmitted frequency, no detectable radiated emissions were observed from the CMI. All detected emissions from the HIC were at least 25 dB below the Part 24 limits.

Measured Field Strength of Spurious Radiation for HIC

Emission Frequency, MHz	Field Strength, dBuV/m	Polarization	Equivalent Spurious Radiated Power, dBm	Part 24 Limit, dBm
1199.00	45.1	V	-52.3	-13
1478.80	43.5	V	-53.9	-13
1518.74	46.2	V	-51.2	-13
1558.60	43.8	V	-53.6	-13
1577.40	42.0	V	-55.4	-13
1598.72	42.3	V	-55.1	-13
1756.28	59.1	V	-38.3	-13
1756.72	52.7	V	-44.7	-13
1768.80	43.2	V	-54.2	-13
1791.40	42.7	V	-54.7	-13
2879.00	44.4	V	-53.0	-13
3498.50	35.9	V	-61.5	-13
3502.61	36.7	V	-60.7	-13
4318.51	40.9	V	-56.5	-13
5210.25	45.0	V	-52.4	-13
5229.00	47.9	V	-49.5	-13
5247.75	48.7	H	-48.7	-13
5255.25	48.4	V	-49.0	-13
5261.40	44.0	V	-53.4	-13

Note: Equivalent spurious power was calculated using Equation (4) above.

4.7 Powerline Conducted Emissions

The HEE underwent powerline conducted emissions tests per ANSI C63.4-1992. Observed emissions were within the limits of CFR 15.107 for Class A digital devices.

4.8 HEE Radiated Emissions (Other Than HIC)

The HEE underwent emissions tests per ANSI C63.4-1992. Observed emissions were within the limits of CFR 15.109 for Class A devices.

4.9 RF Hazard

The CMI has been evaluated for radiofrequency hazards per FCC guidelines and the requirements contained in IEEE-C95.1-1991. When operated and installed in accordance with the instructions, the PCS-over-Cable CMI complies with these requirements. A technical record is maintained by Sanders.

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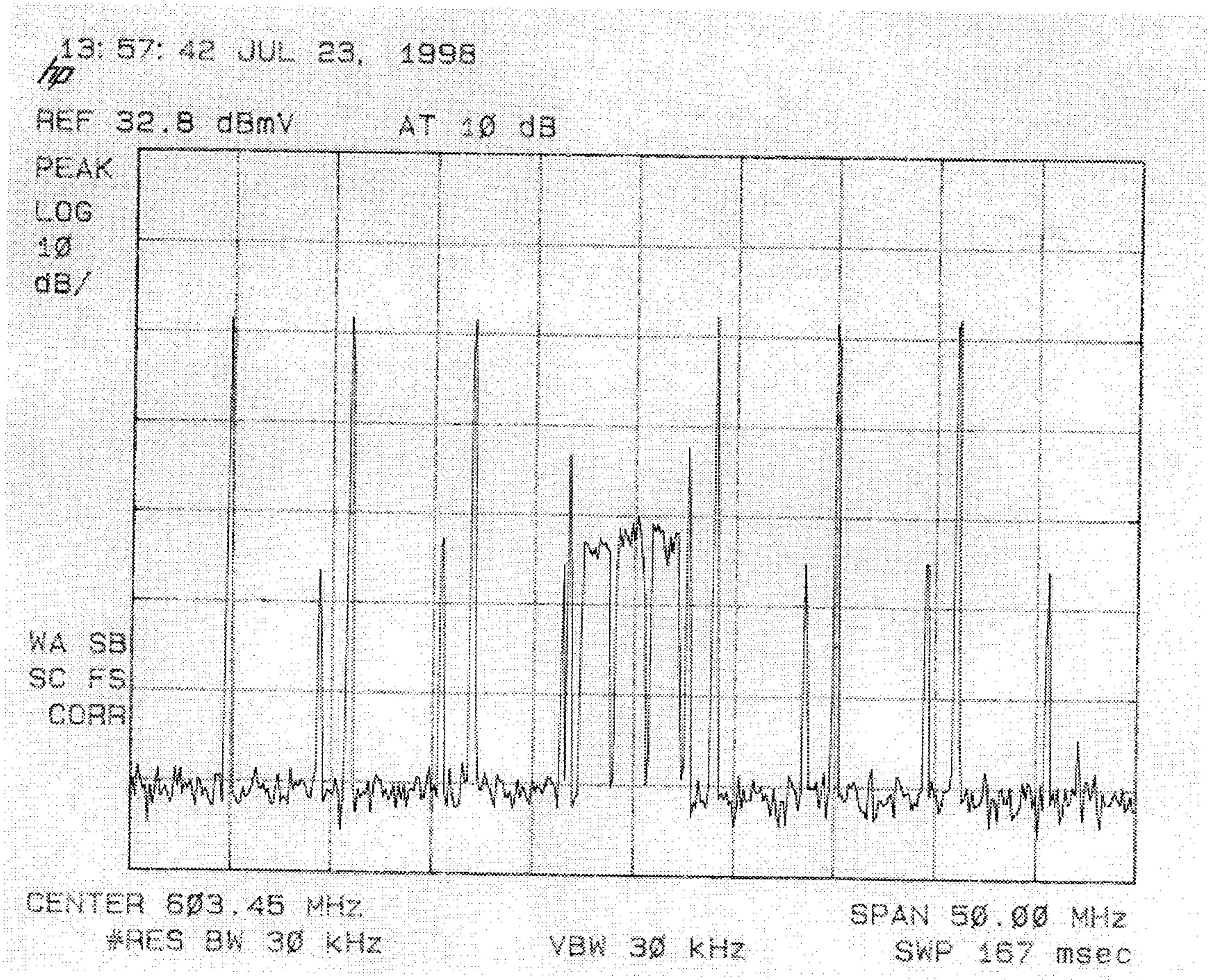

Figure 1 Plot of CMI input, showing 3 adjacent CMDA carriers, with 6 video carriers (3 each side)

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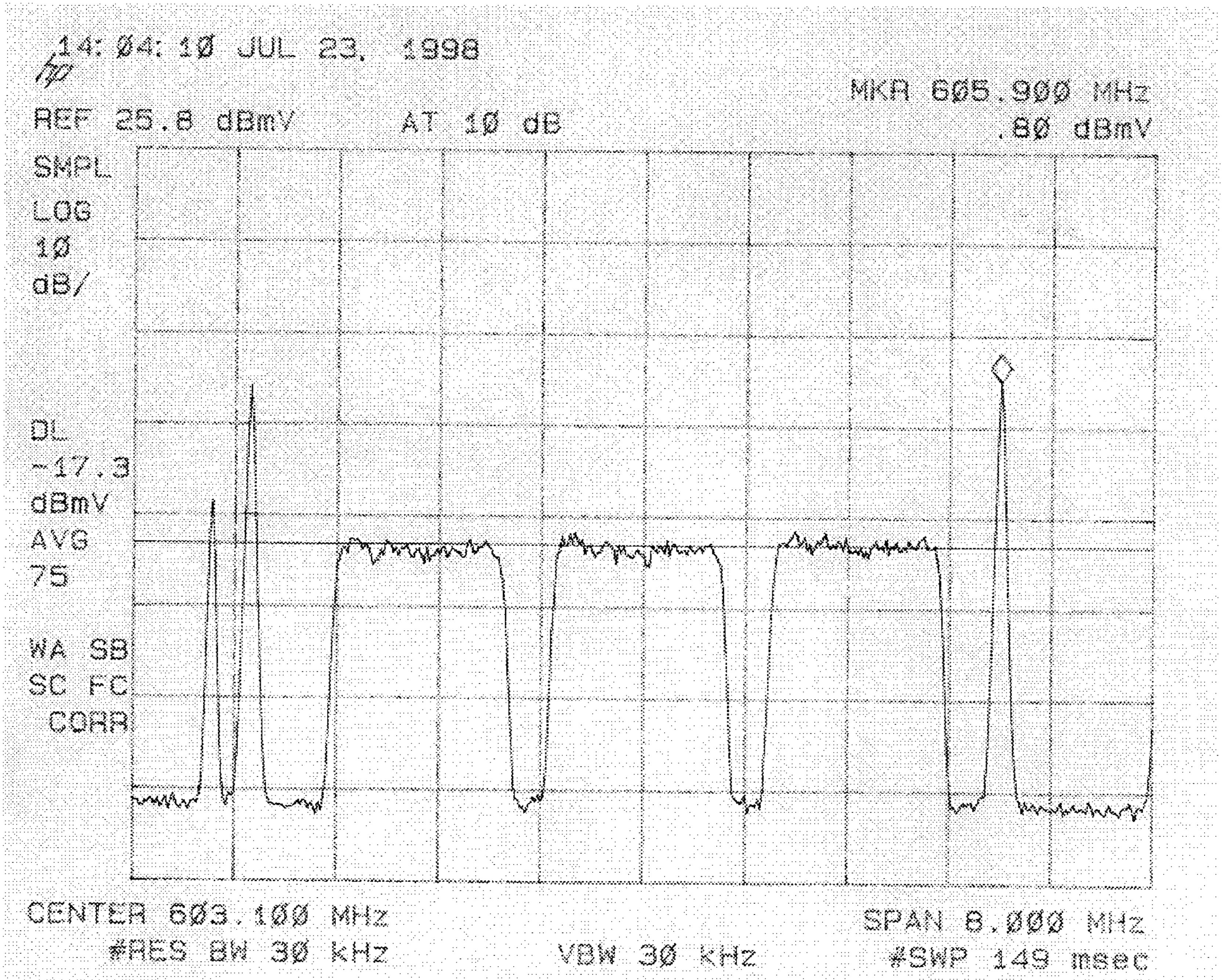

Figure 2 Closeup of 3 CDMA carriers